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Filed: July 25, 2000

#### REMARKS

Applicant acknowledges receipt of the Office Action mailed December 17, 2002. In that Office Action, the Examiner (1) rejected certain claims under 35 U.S.C. § 112, second paragraph; and (2) rejected certain claims under 35 U.S.C. § 103(a) based on *De Jong et al.* in view of, variously, *Kiliany et al.*, *Heck et al.*, *Dubois et al.*, *Goetsch et al.*, and *Heisel et al.*

#### Status of Claims

Claims 1-7, 13-14, 18-20 and 24 were previously cancelled.

Claim 23 is currently amended.

Claims 8-12, 15-17, 21-23 and 25-28 remain pending.

#### Rejection of Claims Under 35 U.S.C. § 112, Second Paragraph

Claim 23 stands rejected under 35 U.S.C. § 112, second paragraph as being indefinite. The Examiner states that the language of claim 23 is directed toward method limitation. In response, Applicants respectfully traverse this rejection for at least the reason that the Examiner appears to be misreading the claim limitation in question as a method limitation. The phrase "wherein said catalyst is active for catalyzing the reactions ..." is clearly a recitation of specific properties or characteristics of the catalyst. The catalyst is a structural element of the system and it is proper to characterize or limit the properties of this claim element as appropriate. Nevertheless, without altering the scope of the claim and to facilitate a clearer understanding of the intended meaning of the limitation in question, claim 23 has been reworded to recite "wherein said catalyst is capable of catalyzing the reactions ...." This limitation is similar to the recitation of "a catalyst suitable for catalyzing the partial oxidation of ..." in claim 8. Withdrawal of this ground of rejection and allowance of claim 23 is respectfully requested.

#### Rejection of Claims under 35 U.S.C. § 103(a)

In the Office Action, claims 8-12, 15-17, 21, 22 and 25-28 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *De Jong et al.* in view of *Kiliany et al.* alone, or in combination with, variously, *Heck et al.*, *Dubois et al.* or *Goetsch et al.*, or over the combination of *De Jong et al.* and *Heisel et al.*

In order to establish a *prima facie* case of obviousness, three criteria must be met: i) there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify or to combine reference teachings; ii) there must

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be reasonable expectation of success; and iii) the prior art references must teach or suggest all the claim limitations. MPEP § 2143. The Court of Appeals for the Federal Circuit has stated,

...a prior patent must be considered in its entirety, i.e., as a *whole*, including portions that would lead away from the invention in suit, *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1550, 220 USPQ 303, 311 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851, 105 S. Ct. 172, 83 L.Ed.2d 107 (1984); elements of separate patents cannot be combined when there is no suggestion of such combination anywhere in those patents, *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984); and a court should avoid hindsight, *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d at 1553, 220 USPQ at 313.

*Panduit Corporation v. Dennison Manufacturing Co.*, 810 F.2d 1568, 1561-1584 (Fed. Cir. 1987). Also, see MPEP § 2141.03. Thus, in order to establish a *prima facie* case of obviousness, the Examiner must show that the claimed invention would have been obvious to one having ordinary skill in the art without the benefit of Applicants' disclosure. The present rejections under § 103 do not adhere to those requirements.

The Examiner has taken the position that it would have been obvious to one of ordinary skill in the art at the time of Applicant's invention to have implemented the sulfur condenser of *Kiliany et al.* for the sulfur removal unit in *De Jong et al.* because both units' purposes are for removing sulfur from a product stream coming from an oxidation reactor. Applicant respectfully traverses this rejection for at least the reason that it incorrectly assumes that the elemental sulfur condenser of *Kiliany et al.* can substitute for *De Jong et al.*'s "desulfurization unit" for removing sulfur-containing components from the carbon monoxide/hydrogen product (*De Jong et al.* (col. 8, ll. 21-27)).

*De Jong et al.* do not distinguish among the many sulfur or sulfur-containing compounds that can be employed in their process (col. 4, l. 65 - col. 5, l. 16). Apparently one suitable organic or inorganic sulfur-containing compound will do as well as another in the process of *De Jong et al.* Hydrogen sulfide is only one of a number of sulfur-containing compounds mentioned that will serve the stated purpose (reduce the formation of ammonia and hydrogen cyanide) (col. 5, ll. 17-22). In fact, the single exemplary process in *De Jong et al.* uses tetrahydrothiophene as the sulfur-containing compound. Since there is no strict requirement for H<sub>2</sub>S in the feed, it would not be reasonable for the Examiner to then assume that elemental sulfur necessarily results from the process of *De Jong et al.* and that a sulfur condenser would be an appropriate desulfurization unit for substitution in the apparatus employed in *De Jong et al.* In the case of tetrahydrothiophene as the sulfur-containing compound, modifying the apparatus as suggested by the Examiner would more likely render the

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resulting system unsatisfactory for its intended purpose. There is no indication is any of the cited references that a sulfur condenser such as that used by *Kiliany et al.* would remove tetrahydrothiophene from a syngas stream. More likely, the proposed modification would destroy the ability of *De Jong et al.*'s apparatus to remove the exemplary sulfur-containing compound from the syngas product. MPEP § 2143.01 "The Proposed Modification Cannot Render the Prior Art Unsatisfactory for Its Intended Purpose."

Moreover, it is highly unlikely that a syngas production process employing a feed gas stream containing only 0.05 to 100 ppm of a sulfur-containing compound (as taught by *De Jong et al.*) would call for a sulfur condenser, even if  $H_2S$  were employed as the sulfur-containing compound. Because current technology can barely achieve product streams having sulfur levels as low as 0.05 - 100 ppm using conventional tail gas treatments, it follows that one of ordinary skill in the art would not consider the addition of a sulfur condenser to the end of *De Jong et al.*'s process necessary or particularly beneficial.

#### ***De Jong et al.* Fails as Primary Reference**

While the Examiner acknowledges that *De Jong et al.* fail to teach a sulfur condenser as their sulfur removal unit, he has overlooked the fact that *De Jong et al.* also does not teach all of the other limitations of claim 8.

**Catalyst.** For example, there is absolutely no teaching or suggestion in *De Jong et al.* of a catalyst that is capable of catalyzing the partial oxidation of  $H_2S$ . It is contrary to the teachings of *De Jong et al.* for the Examiner to assume that any "catalyst capable of catalyzing the partial oxidation of the hydrocarbon feedstock" (col. 4, ll. 1-6) would necessarily be capable of also catalyzing the partial oxidation of  $H_2S$ . The error of such an assumption is apparent in light of *De Jong et al.*'s own statements at (col. 5, ll. 1-5 and 19-22)

Any suitable sulfur-containing compound may be employed which does not give rise to a significant adverse effect to the performance of the partial oxidation reaction when present in the required amount.

However, the quantity of the sulfur-containing compound should not be so great as to significantly reduce either the activity or the selectivity of the catalyst being employed.

It is plain that one of ordinary skill in the art would have no guidance in this reference for selecting a catalyst with the properties recited in claim 8. Only by hindsight reconstruction of claim 8 using Applicant's specification for guidance would one of ordinary skill in the art have any idea to test

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catalyst compositions for their ability to catalyze both types of partial oxidation reactions (hydrocarbon and H<sub>2</sub>S). None of the cited references provide the missing teachings.

**Process.** In paragraph 11 of the Response to Arguments, the Examiner takes the position that *De Jong et al.* teach that their apparatus is used for catalytic partial oxidation (col. 3, ll. 34-36) of light hydrocarbons (col. 4, ll. 20-25) and H<sub>2</sub>S (claim 14), concluding that this is the same process intended for the instant invention. The Examiner states that "it is obvious if the same reactants are used in the same process, the products should be the same as well." In response, Applicant strongly traverses that misinterpretation of the reference and the Examiner's erroneous conclusion. While both *De Jong et al.*'s process and that of Applicant are directed at synthesis gas production by partial oxidation of light hydrocarbons, each process is carried out differently. The composition of the reactant gas mixture, reaction conditions and product gas handling are different. It is therefore incorrect and an over generalization to say that the processes are the same. The cited passages, and in fact, the entire *De Jong et al.* reference, do not indicate that their sulfur-containing compound, is partially oxidized and that elemental sulfur and water are produced as a result. The reference as a whole teaches a method and apparatus for reducing the ammonia and hydrogen cyanide produced during syngas production by including in the feed a slight amount of a sulfur-containing compound (which can be H<sub>2</sub>S or a variety of other compounds) (col. 3, ll. 60-63). There is no indication how this result is accomplished, however. More specifically, *De Jong et al.* state at col. 5, ll. 17-31,

The sulfur-containing compound should be present in sufficient concentration to reduce the formation of ammonia and hydrogen cyanide. However, the quantity of the sulfur-containing compound should not be so great as to significantly reduce either the activity or the selectivity of the catalyst being employed. Thus, the sulfur containing compound is preferably present in the feed mixture in an amount to give a sulfur (S) content in the range from 0.05 to 100 ppm, more preferably from 0.1 to 50 ppm, especially from 0.1 to 10 ppm. Hydrocarbon feedstocks used directly from naturally occurring reservoirs in which the sulfur content is significantly above the aforementioned upper limits may preferably be subjected to a partial sulfur removal treatment before being employed in the process of the invention.

There is no provision in *De Jong et al.*'s process for controlling the relative concentrations of H<sub>2</sub>S and hydrocarbon at Applicant's mole ratio of about 1:10 to about 2:3 (H<sub>2</sub>S : hydrocarbon). Neither is there any suggestion of controlling the rate of feed of an H<sub>2</sub>S stream. By contrast, at page 8, l. 21 - page 9, l. 3 of the Specification, Applicant states:

...the rate of feed of H<sub>2</sub>S into the system is controlled and adjusted so that the heat generated by the oxidation of the H<sub>2</sub>S is sufficient to maintain the desired temperature in reaction zone 20 and thus reduce the amount of the light hydrocarbon that is

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completely combusted. Hence, the mole ratio of  $H_2S$  to light hydrocarbon in the feed is preferably in the range of from about 1:10 to about 2:3. Where the light hydrocarbon is methane, a preferred ratio of  $H_2S$  to methane is 2:3.

The upper limit of the amount of sulfur-containing compound of *De Jong et al.* is based on the requirement that it not alter selectivity or activity of the catalyst [for converting hydrocarbon to synthesis gas].

By contrast, in Applicant's process  $H_2S$  is partially oxidized along with the hydrocarbon as a way of decreasing the selectivity for undesirable  $CO_2$  product during syngas production and at the same time producing valuable elemental sulfur. Accordingly, the claimed system or apparatus requires a cooling zone that includes a sulfur condenser. Applicant specifically teaches manipulating the relative amounts of the reactants and the process conditions to alter the selectivity of the catalyst such that  $CO_2$  production by the catalyst is decreased compared to what it would be otherwise (page 8, l. 21 - page 9, l. 3 of Applicant's specification). *De Jong et al.* do not control their process conditions in this manner. How, then, could the process of *De Jong et al.* be the same as that of Applicant's? Only by hindsight reconstruction of claim 8 using Applicant's specification for guidance would one of ordinary skill in the art have any idea to devise reactant concentrations and process conditions that will favor both reactions (partial oxidation of hydrocarbon and partial oxidation of  $H_2S$ ) taking place, and that will minimize  $CO_2$  production and enhance selectivity for CO and  $H_2$  products. None of the cited references provide the missing teachings.

**Cooling zone.** In the process of *De Jong et al.* it appears that the product stream enters the desulfurization unit only after the product gases are cooled. See Fig. 1 of *De Jong et al.* and col. 8, ll. 4-17:

3The hot product stream of the catalytic partial oxidation reactor 2 is led via line 8 to a heat exchanger 10, in which the hot product stream is used to preheat natural gas fed to the heat exchanger by line 12. The preheated natural gas feed is supplied to the inlet of the catalytic partial oxidation reactor via line 14.

The cooled product stream of the catalytic partial oxidation reactor is removed from the heat exchanger via line 16. A product stream comprising carbon monoxide and hydrogen is withdrawn from the process via line 18 to be employed as a feed for sulfur-tolerant applications (not shown). A portion of the cooled product stream is supplied via line 20 to a desulfurization unit 22. [underlining added]

There is no indication that any cooling takes place in desulfurization unit 22 of *De Jong et al.* after the product (including the sulfur-containing compound) splits off at line 18, and clearly no teaching or



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suggestion that cooling to below the dew point of elemental sulfur must take place in desulfurization unit 22. By contrast, Applicant's sulfur condenser is part of the cooling zone, as recited in claim 8.

The Examiner has acknowledged that *De Jong et al.* is silent to a means for recovering elemental sulfur (paragraph 7 of the Response to Arguments). In fact, *De Jong et al.* only teach a desulfurization unit that is well known in the art for removing sulfur-containing components from the carbon monoxide/hydrogen product (col. 8, lines 21-27). Suitable techniques suggested by *De Jong et al.* are adsorption of the sulfur-containing compounds by passing the product stream through a bed of a suitable adsorbent, for example, active carbon or zinc oxide. It seems clear that the suitable desulfurization unit contemplated by *De Jong et al.* would need to be appropriate for removing various sulfur-containing compounds mentioned by *De Jong et al.* None of the cited references teach or suggest that a sulfur condenser is a known technique for removing sulfur-containing compounds from synthesis gas. Since *De Jong et al.* specifies a desulfurization unit that can remove "sulfur-containing compounds," and mentions a variety of such organic and inorganic compounds, it is doubtful that a sulfur condenser would be a suitable desulfurizer for removing most of those compounds from a synthesis gas product stream. Sulfur condensers are well known for condensing sulfur from Claus process streams, but not for cleanup of synthesis gas product streams.

Prior to Applicant's disclosure, it was unknown in the art to employ a sulfur condenser after a catalytic partial oxidation reactor for receiving partially cooled synthesis gas containing gaseous elemental sulfur, and recovering liquid elemental sulfur from the synthesis gas product mixture. Once again, in assuming that a "well known technique for removing sulfur-containing compounds from synthesis gas" is the same thing as the sulfur condenser used in the distinctly different process and system of *Kiliany et al.*, the Examiner disregards the incompatibilities and teaching away in *De Jong et al.* This strongly suggests that the teachings of Applicant's own specification are being improperly used for guidance in picking and choosing elements from the art in an attempt to reconstruct the claimed invention.

Although claim 23 does not stand rejected on any of the cited references, the Examiner has nevertheless stated in the Office Action at paragraph 9 of the Response to Arguments:

... *De Jong et al.* discloses the same reactants in a same partial oxidation reaction for  $H_2S$  and light hydrocarbons. So very most likely, the actual reaction occurring is the same as the one disclosed in claim 23.

Applicant strongly traverses that statement for at least the same reasons as discussed above with respect to claim 8. The primary reference cited by the Examiner does not teach or suggest producing elemental

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sulfur during production of CO and H<sub>2</sub>. As discussed above, the Examiner's position is incompatible with the exemplary process described in the *De Jong et al* reference. For example, would tetrahydrothiophene behave the same way as the Examiner proposes for H<sub>2</sub>S and yet be interchangeable with H<sub>2</sub>S in the process of *De Jong et al*? Moreover, *De Jong et al*. do not teach or suggest taking steps to ensure a favorable balance between competing reactions, minimizing the amount of light hydrocarbon that is combusted to CO<sub>2</sub>, or maintaining a favorable molar ratio of H<sub>2</sub>S to carbon (see pp. 9-10 of Applicant's specification). None of the cited references supply the missing teachings. This deficiency is especially manifest in the teaching of *De Jong et al*. that sulfur or any other organic or inorganic sulfur-containing compound could be used for the same purpose. *De Jong et al*. is silent as to how the sulfur-containing compounds actually provide the desired reduction in production of ammonia and hydrogen cyanide in the synthesis gas product. Since there is no indication that any of the suitable sulfur-containing compounds mentioned by *De Jong et al* are converted to elemental sulfur product, it is incorrect to conclude that the same process as taught by Applicant and that the claimed apparatus for carrying out Applicant's process is obvious over the teachings of the combined references.

Therefore, because there is no teaching or suggestion to use a sulfur condenser in the apparatus of *De Jong et al*., because there is ample teaching away in the references, because *De Jong et al*'s desulfurization unit is not part of the cooling zone, and because there is no reasonable expectation that the sulfur content could be decreased by substituting a sulfur condenser for the desulfurization unit of *De Jong et al*., Applicant asserts that motivation to combine *De Jong et al*. with *Kiliany et al*. is lacking. Moreover, since *De Jong et al*. fails as a primary reference as relied on in this rejection, even if one were to try to combine the references as suggested, there could be no reasonable expectation that the resulting apparatus would be the same as the claimed invention. For at least the foregoing reasons, independent claim 8, and claims 15, 17, 21, 22 and 25 which depend directly or indirectly therefrom and add limitations thereto, are believed to be non-obvious over the combination of *De Jong et al*. and *Kiliany et al*.

#### Claims 26-28

With respect to the rejection of claims 26-28 over the combination of *De Jong et al*. and *Heisel et al*., Applicant also respectfully traverses for substantially the same reasons as discussed above with respect to the combination of *De Jong et al*. and *Kiliany et al*.. The Examiner takes the position that the sulfur recovery means of *Heisel et al*. is combinable with the teachings of *De Jong et al*. for the purpose of having useful sulfur at the end of the process. It should be noted that the processes of *De*

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*Jong et al.* and *Heisel et al.* are quite different and the intended products are different. Moreover, the amount of sulfur in *De Jong et al.*'s feed mixture is very low (e.g., 0.05 to 100 ppm). The primary reference does not teach that elemental sulfur is necessarily and inevitably produced in the same reactor along with syngas. There is no teaching of a means for effecting both the catalytic partial oxidation of  $H_2S$  to elemental sulfur and  $H_2O$  and the catalytic partial oxidation of light hydrocarbon to form  $CO$  and  $H_2$  products in a single reaction zone. As discussed above, to assume otherwise would require disregarding *De Jong et al.*'s exemplary embodiment and likely rendering the process and apparatus of *De Jong et al.* inoperable with respect to the ability to remove the sulfur-containing compound. There is no teaching of how to establish process conditions that will ensure that both catalytic partial oxidation reactions take place. Moreover, it is doubtful that, in the instance where  $H_2S$  is employed by *De Jong et al.* as the sulfur-containing compound, the amount of sulfur produced, if any, would be significant enough to merit trying to recover it as useful sulfur product. There is no teaching of a means for cooling the product stream below the dew point of sulfur (claim 26).

Because the production and/or recovery of elemental sulfur is clearly not taught or suggested in *De Jong et al.*, the process is different, the catalyst is different, the desulfurization unit is not a part of the cooling zone, and cooling below the dewpoint of sulfur is not taught or suggested, there can be no motivation to add a means for removing elemental sulfur to the apparatus of *De Jong et al.* Therefore, there is no motivation to combine *De Jong et al.* with *Heisel et al.* For at least these reasons, independent claim 26 and claims 27-28 which depend directly or indirectly from claim 26 are nonobvious over the combination of *De Jong et al.* and *Heisel et al.*

**Claims 9, 10, 11, 12 and 16**

Claims 9-12 and 16, which depend directly or indirectly from claim 8, also stand rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of *De Jong et al.* and *Kiliany et al.* in view of, variously *Heck et al.*, *Dubois et al.* or *Goetsch et al.* Because *De Jong et al.* fail as a primary reference, as discussed above, and because *Kiliany et al.* do not provide the necessary teachings that would result in the apparatus of claim 8, it is believed that claims 9-12 and 16 are also non-obvious over the cited references for at last the same reasons as claim 8. Neither of the *Heck et al.*, *Dubois et al.* or *Goetsch et al.* references correct the failings of the combined teachings of *De Jong et al.* and *Kiliany et al.* Even if one were to modify the system of *De Jong et al.* as proposed by the Examiner with the mixing zone, thermal barrier, oxygen injection line or wire gauze catalyst of *Heck et al.*, *Dubois et al.* or *Goetsch et al.*, one would still not have the claimed apparatus of any of claims 9-12 and



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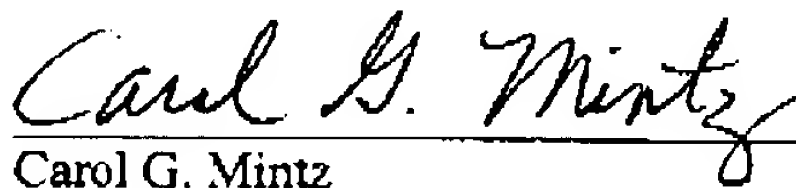
16 because *De Jong et al.* does not teach all of the other limitations of Applicant's claimed apparatus as relied on by the Examiner.

Conclusion

Applicant may have at times referred to claim limitations in shorthand fashion, or may have focused on a particular claim element. This discussion should not be interpreted to mean that the other limitations can be ignored or dismissed. The claims must be viewed as a whole, and each limitation of the claims must be considered when determining the patentability of the claims. Moreover, it should be understood that there may be other distinctions between the claims and the prior art, which have yet to be raised, but which may be raised in the future.

Consideration of the foregoing amendments and remarks, reconsideration of the application and withdrawal of the rejections and objections is respectfully requested by Applicant. No new matter is introduced by way of the amendment. It is believed that each ground of rejection raised in the Office Action dated December 17, 2002 has been fully addressed. However, if a telephone conference would facilitate the resolution of any issue, the Examiner is invited to telephone the undersigned at 713-238-8000. If any fee is due as a result of the filing of this paper please appropriately charge such fee to Deposit Account Number 03-2769 of Conley Rose, P.C., Houston, Texas. If a petition for extension of time is necessary in order for this paper to be deemed timely filed, please consider this a petition therefor.

Respectfully submitted,



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